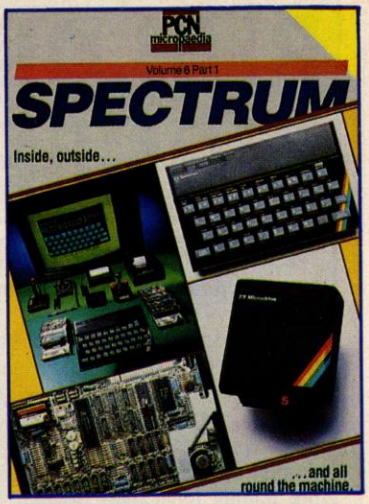
# MICRODRIVE REVOLUTION




VOLUME 6

At the time of writing, Sinclair's long-awaited low-cost storage unit — the Microdrive — is to be launched within weeks.

There has been much speculation as to how the machine works — whether it is a stringy floppy or a floppy tape or other wilder possibilities.

The Microdrive has two components — the expansion module you need to make it attach to your Spectrum and, of course, the drive itself.

The £30 expansion module not only gives you access to the ever-elusive Microdrive, but also gives you motor drive control over cassette-tape storage, a plug-in for local area networking and an RS232 interface.

Microdrives are offered to Spectrum owners in the order in which they bought their machines. Orders are limited to two per customer to begin with, but once every Spectrum owner has had the chance to buy a Microdrive you'll be able to go back to Sinclair for 'seconds'.

## Communications facility

The Microdrive can store up to 100K at a rate of 16K per second with an average access time of 3.5 seconds. At £40 the Microdrive sounds like good value.

You can have up to eight Microdrives running off one Spectrum, and the communications facility built in to the Microdrive expansion module allows you to 'talk' to as many as 64 other Spectrums.

Communication is allowed at baud rates of 9600, 4800, 2400, 1200, 600, 300, 200, 100 and 50 — so few machines need feel left out.

Sinclair also offers commercial programs on Microdrives. These should be of a more comprehensive nature than is currently available, as they'll have built-in data storage space.

The fact that the Microdrive arrangement could be the start of a low-cost storage revolution that will change the face of microcomputing in the UK isn't lost on Sinclair Research. It plans to make sure Sinclair computers are the only machines to take advantage of this revolutionary technology. Contrary to rumour, the Microdrives are not being sold to interface with other popular micros.

## Expansion trail

The Microdrive is one of several expansion modules that will make the Spectrum a more powerful machine. Also soon to hit the market will be a plug-in cartridge software interface and joystick adapter. The use of the joystick adapter is obvious, but the cartridge software plug-in suggests interesting possibilities for interfacing with the Microdrive.

With software on plug-in ROM cartridges selling for under £10 and two Microdrives each with 100K of storage, you can seriously consider using the Spectrum for small business applications. The ROM cartridge would hold perhaps a spreadsheet program — the 48K in an expanded Spectrum giving a workspace area — while the Microdrive allows a large area for storage of records.

## Challenges

Of course, the primary storage facility of the Spectrum until now has been the cassette recorder — and this will be the case for some time. You can expect a spate of articles on how to load your library of programs from cassette to the Microdrive. There will be all sorts of challenges — particularly in taking machine code routines from store-bought cassette programs and attempting to move them to the Microdrive.

Another challenge will be the use of the networking interface so that several machines could share a bank of Microdrives as a common storage facility. If it has any of the teething troubles of Acorn's Econet local area networking system for the BBC Micro, there is likely to be a considerable delay before a workable system is achieved.

But as the Microdrive design was being reworked right up to the point of launch, it's difficult to say exactly what other problems might be encountered with it. Needless to say, however, it will be very much in the news over the next few years and will act as a catalyst in bringing down the cost of mass storage for micros.

At £40 for 100K of random access storage, you're paying only 40p for each kilobyte — a fraction of the cost of disk storage three years ago.

**The Microdrive in this picture has been used in all Sinclair's publicity about the Spectrum since the micro was launched. As designs for the Microdrive have apparently been evolving and changing right up until the point of launch, the black box you see below is likely to be empty — although it does give the general idea of what the drive will look like. But you can be sure that, as soon as the mysterious black box actually houses the next storage revolution, *PCN* will let you see what's inside.**

# BUILDING A BIGGER SYSTEM

**There's a problem with the Spectrum when it comes to connecting joysticks — it doesn't have any.**

**Fortunately this problem has been overcome: in computing nearly anything is possible if enough people want it. Although the Spectrum was designed to be used through its keyboard and most of the games have been written to expect keyboard commands, there are alternatives.**

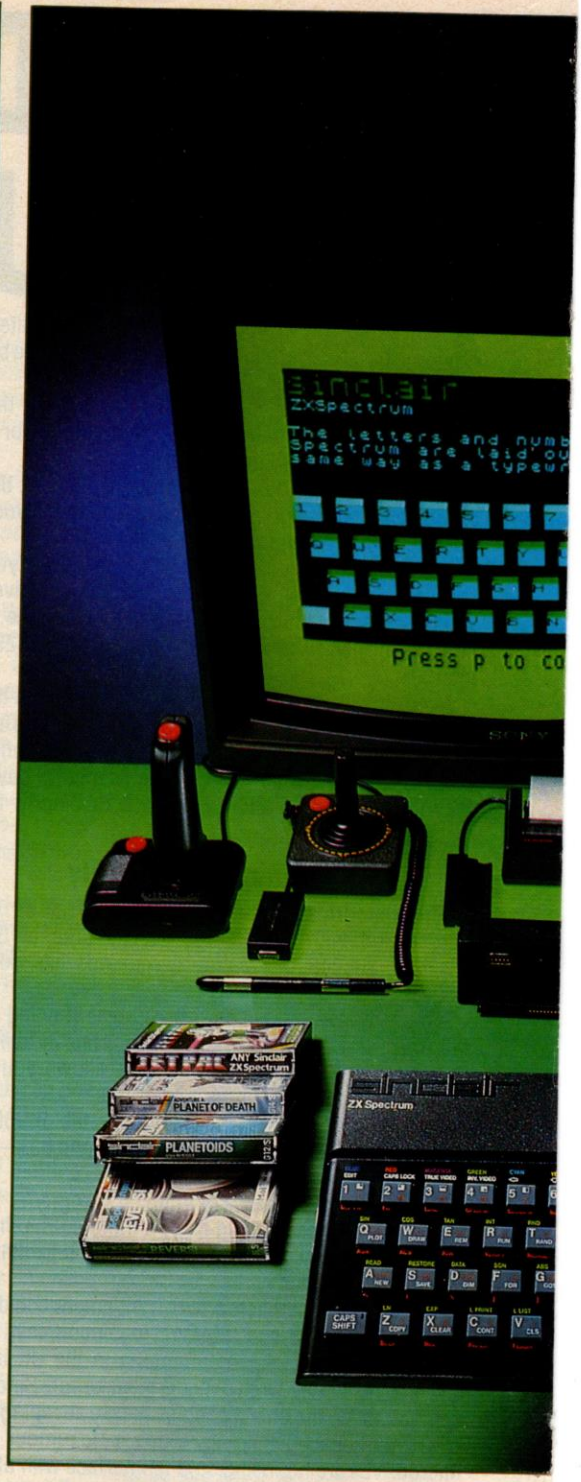
It is becoming obvious that many are prepared to pay extra for a joystick facility — so many, in fact, that Sinclair has recently announced that its distant (if the Microdrives are anything to go by) plans for a games cartridge facility will include joystick controllers.

While Sinclair works on its joysticks, however, other companies are busily selling a variety of alternatives. A frontrunner is the Kempston joystick interface (*see PCN Peripherals, issue 13*). This fits on the edge connector at the back of the Spectrum and looks like a RAMpack. The joystick is plugged into the interface through a standard Atari/Commodore connection.

Although there is a respectable number of compatible games available and these promise to increase all the time, your non-compatible software won't work.

This is where the Pickard Joystick Controller comes in (*PCN, Issue 11*). The controller attaches via a ribbon cable to the keyboard ribbon socket so the controller fools the processor into thinking it's the keyboard and it sends strings of characters to tell it what to do.

Because different games use different keys to go up, down, left, right or fire you insert five jack plugs on the end of five short cables into a grid of sockets representing the Sinclair keyboard, telereceptionist-style. This controller also uses the standard Atari/Commodore plugs.




## COMMUNICATIONS/INTERFACES

**To allow your Spectrum to communicate with the outside world an interface of some sort is essential. There are basically two types: the 'interim' onto which you plug something else, eg lights, printers, robots etc, OR the types that come with joysticks, digitizers, lightpens incorporated.**

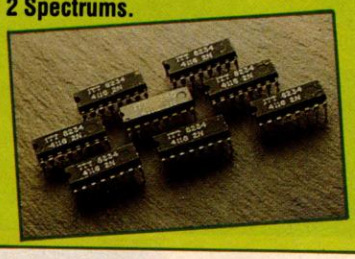
**Centronics interface,** £45 inc p&p+VAT. Available from Kempston Micro Electronics, 180a Bedford Road, Kempston, Bedford, MK42 8BL. Complete self-contained interface which allows you to connect the Spectrum to a wide range of printers: Epson, Seikosha 100A, Oki Microline 80 etc. Includes driving software and cable.

**Cobra,** £30 inclusive. Available from COBRA Technology, 378 Caledonian Road, Islington, London N1 1DR. Fully cased, attaches to back of Spectrum. Allows Spectrum to communicate with other machines. Communications software, £4.50 extra.

**Joystick** Interface II, £20.95. Available from AGF Hardware, 26 Van Gogh Place, Bognor Regis, West Sussex, PO22 9BY. Allows you to use any Atari Joystick (2).

## RAM

**When buying RAM for the ZX Spectrum, you should note whether the RAM comes as part of a kit or simply plugs into the back. Some RAM will operate only with type 1 or 2 Spectrums.**



**Upgrade Kit,** £24.50 inc p&p. Available from Fox Electronics, 141 Abbey Rd, Basingstoke, Hants, RG21 9ED. No soldering necessary, 48K RAM, issue 2 machines only.

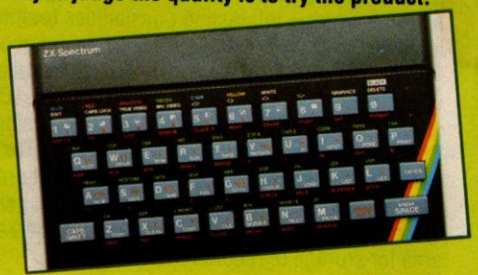
**Spectrum Budget Pack,** issue 1 £44.95, issue 2 £34.95. Available from JRS Software, 0903-65691. 32K RAM, kit form.

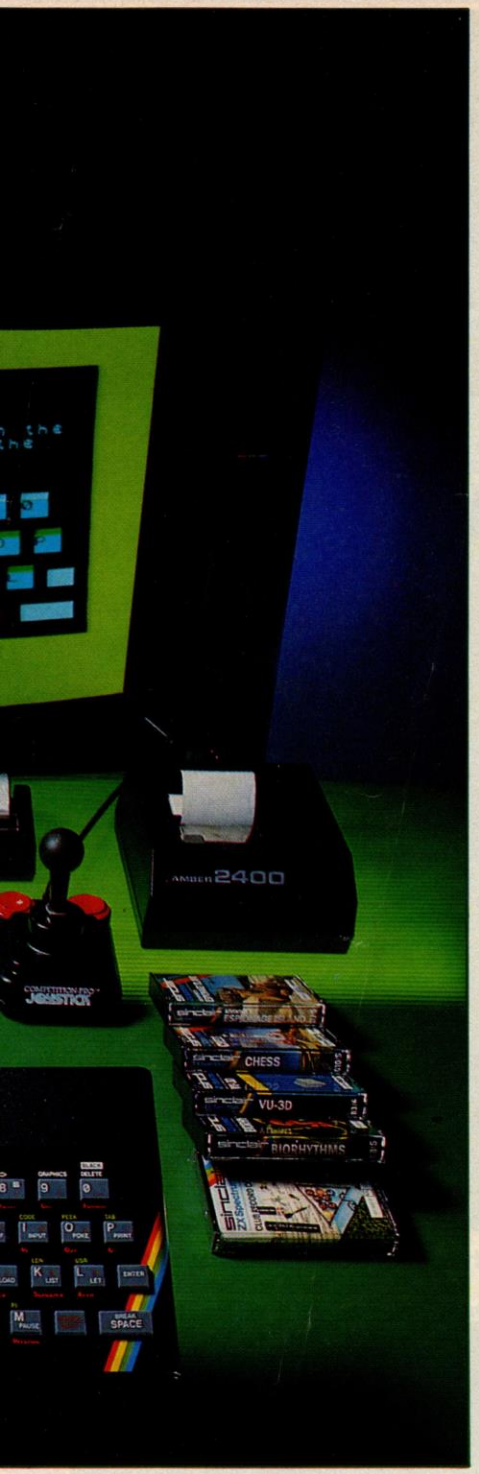
**ME80 Series, 80K RAM.** ME48 Series, 48K RAM. Available from Computer Add-ons. Prices: ME48 series A, £34.50: series B, £24,50. ME80 series A, £49.50; series B, £49.50. No soldering, plug-in, add 40p p&p.

**Plug-in RAM Pack,** £44.95+£2 p&p. Available from Kayde Electronic Systems, 0493 55253. 32K RAM pack which plugs into the back of the Spectrum.

## KEYBOARDS/WORKSTATIONS

**There are quite a few keyboards and cases available for the Spectrum. Many of these are like the cases available for the ZX81, and some of them are just as bad. You may like to look in some of the High Street computer stores before buying, because the only way to judge the quality is to try the product.**



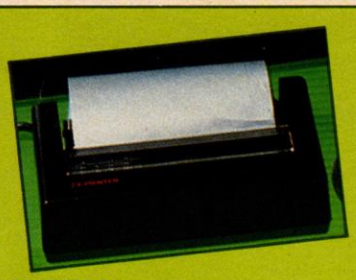



**oard,** £29.95+£2 p&p. Available from Fox tronics. 42 keys, replace Spectrum PCB into the case. No soldering required.

**2,** £29.95+80p p&p. Available from Fuller Micro ems, 051-236 6109. Full-size typewriter oard and case. Can enclose the Spectrum PCB power supply. No soldering necessary.

**Vorkstation,** POA. Available from Peter Furlong ucts, 07914 81637. Moulded ABS 'plinth' type d for the Spectrum. Power supply fits underneath, the Spectrum for better typing.

**y-Case,** £34.95+ £2 p&p. Available from putex Cases, Stanhope Road, Camberley, Sur- GU15 3PS. Executive type briefcase. Specially gned to hold Spectrum, PSU, Printer, Tape rder and cassettes. Lift off top for working.



## PRINTERS

**The ZX printer is the most widely-used for the Spectrum and ZX81 computers and simply plugs into the machines' expansion boards.**

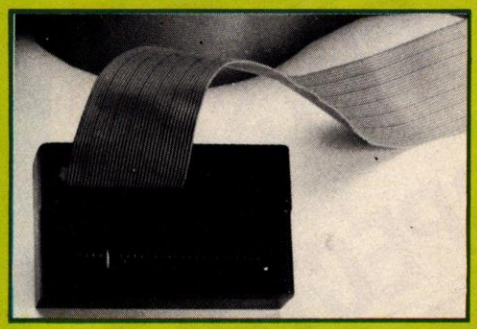
**The Amber 2400 is a small 20-character dot matrix printer using ordinary paper with a small**

**ink ribbon. It can be interfaced to a number of popular micros, including the BBC, Spectrum and Dragon computers.**

For many months after the introduction of the Spectrum, Sinclair's own ZX Printer was the only printer that could be interfaced to the micro.

The silver-paper electrical ZX Printer — which currently sells for £40 — was good enough for listings and some screen dumps, but it required special paper onto which the printer could 'burn' the text and had a limited width.

Since then, alternative 'listings' printers like Amber's 2400 have appeared to supplement the Sinclair printer and the interfaces to allow it and regular



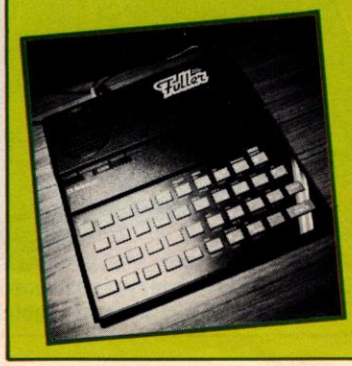
80-column type dot matrix printers to be used with the Spectrum.

The £89.95 Amber printer has been available since Christmas 1982, but due to a recent change in management at the company that makes the printer it is currently undergoing a redesign. Kempston Micro Electronics and other peripheral manufacturers have produced a £45 interface which allow you to use Centronics type printers (which include the Amber). The only drawback to the 'real' printers used with the Spectrum is that they can't print the machine's user-defined graphics — you'll still need the good old ZX printer to do that.

## SOUND AND SPEECH

**The Spectrum is now very well endowed with sound, speech and music add-ons. Most of them are attached to the back of the machine by an interface, which normally comes with the device. Sound is then generated by a special sound/music chip, which is addressed by program control.**

**But the variety of sound add-ons available means you could have a problem deciding which one to buy. Before you take the plunge, you should find out whether a speaker is included, and if there is a socket for channeling the output through an external speaker.**




**The Zon X 81,** £29.95 inc p & p + VAT. Available from Bi-Pak, 0920-3182. Complete self-contained unit, plugs into back of Spectrum. No power pack necessary, manual volume control on unit. Eight octaves, uses three-channel sound chip with program control of pitch, volume, tones and noise. Addressed by Basic or machine code.

**Echo,** £23.50 inc p&p+VAT. Available from Micro Marketing, 01-736 1683. Amplifies existing sound from the Spectrum's BEEP command, with additional control of volume, tone. No additional power supply needed. Attaches to the ear and mic sockets.

**Add-on,** £19.50+VAT+55p p&p. Available from Micro Power, 0532-683186. Sound generator and joystick port. Uses AY-3-8190 sound chip. Three-channel control with amplification, sound chip is processor independent. Comes with demonstration cassette.

**Super Talker,** £69.95+VAT. Available from Namal Associates, 0223-355404. Plugs into back of Spectrum. 550-word vocabulary, 2K internal RAM, ½ watt amplifier with internal speaker. Can be programmed by user control. Jack socket for external control.

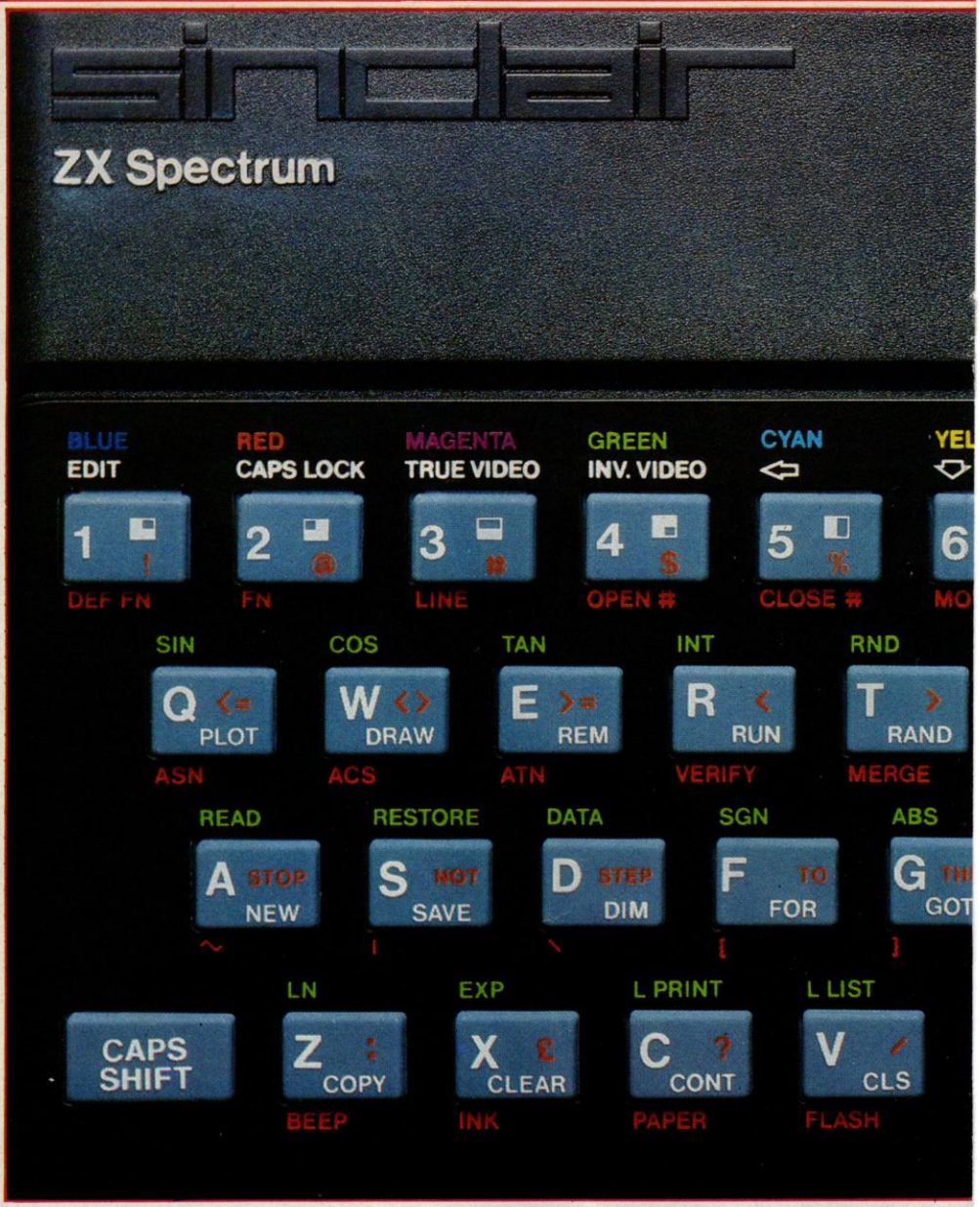
**TS 2000 SS1 Speech Synthesiser,** £39.00+40p p&p. Available from Computer Add-ons, 7-9 Thane Works, Thane Villas, London N7. Plugs into back of Spectrum. No extra batteries needed. Produces speech effects and comes with dictionary of sounds. Can be connected to external hi-fi.

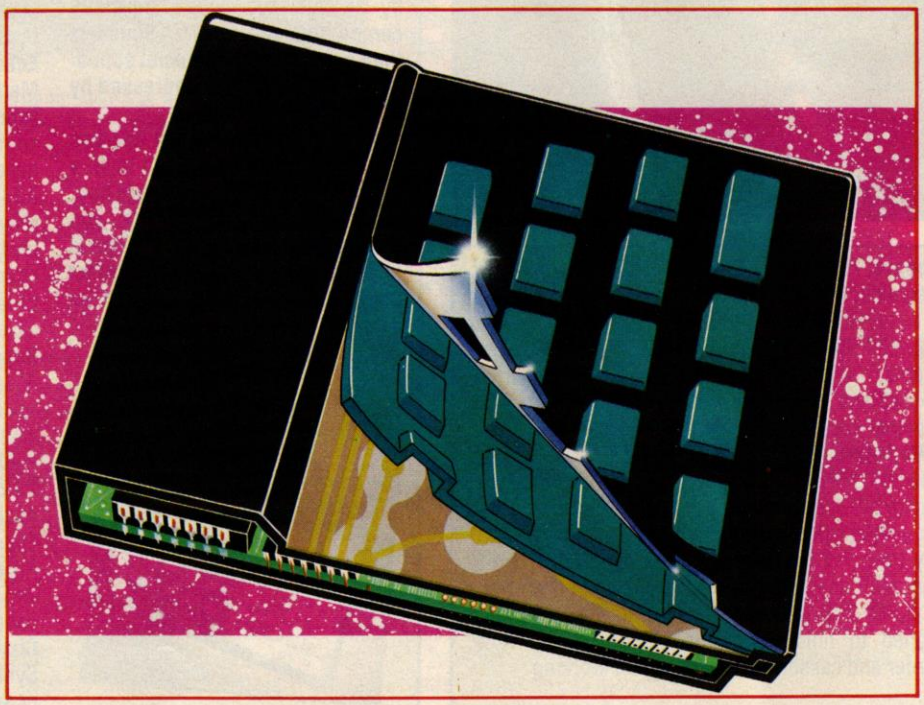
**Chatterbox,** £49+VAT. Available from William Stuart Systems, 01-221 1131. Unlimited vocabulary (phonetic synthesis), self-contained speaker/amplifier.

# OUTSIDE THE SPECTRUM

**The Spectrum keyboard inspires great emotion in its users. They either express a fierce attachment to its multi-function soft rubber keys or hanker for the electric typewriter keys that adorn more expensive machines. But all Spectrum users will admit to confusion at one time or other in trying to find keywords on their machine and the alphabetic listing on this page is intended to ease that confusion. Simply decide on the keyword you want to type in and look down the alphabet to see what combination of keys you need to press. There are five or more functions on each of the keys and the colours green, red, and white denote them.**

**ABS** Caps and Symbol, G
**ACS** Caps and Symbol, W
**AND** Symbol and Y
**ASN** Caps and Symbol, Caps and Q
**AT** Symbol and I
**ATN** Caps and Symbol, Caps and E
**ATTR** Caps and Symbol, Caps and L
**BEEP** Caps and Symbol, Caps and Z
**BIN** Caps and Symbol, B
**BRIGHT** Caps and Symbol, Caps and B
**CAPS LOCK** Caps and 2
**CAT** Caps and Symbol, Caps and 9
**CHR$** Caps and Symbol, U
**CIRCLE** Caps and Symbol, Caps and H
**CLOSE#** Caps and Symbol, 5 and Symbol
**CODE** Caps and Symbol, I
**COS** Caps and Symbol, W
**DATA** Caps and Symbol, D
**DEF FN** Caps and Symbol, Symbol and 1
**DELETE** Caps and 0
**EDIT** Caps and 1
**ERASE** Caps and Symbol, Symbol and 7
**EXP** Caps and Symbol, X
**FLASH** Caps and Symbol, Caps and V
**FN** Caps and Symbol, Symbol and 2
**FORMAT** Caps and Symbol, Symbol and O
**GRAPHICS** Caps and 9
**IN** Caps and Symbol, Caps and I
**INK** Caps and Symbol, Caps and X
**INKEY$** Caps and Symbol, N
**INT** Caps and Symbol, R
**INVERSE** Caps and Symbol, Caps and M
**LEN** Caps and Symbol, K
**LINE**, Caps and Symbol, Symbol and 3
**LLIST** Caps and Symbol, V



In this cutaway view of the Spectrum keyboard, you can see how the rubber-membrane entry system works.

The top layer of the keyboard is a metal overlay with various keywords and symbols printed on it. The concept behind this overlay design has been used by companies like Softeach (25 College Road, Reading, Berkshire) in offering its own overlay for the Spectrum.

The idea behind Softeach's overlays is customisation. They allow you to design a different overlay for each game or applications package running on your machine. And for a complicated game, like Flight Simulation, a specially designed overlay can be a great help in remembering where all your controls are.

Below the Spectrum's metal overlay is the stamped-rubber keyboard itself. If you took off the metal overlay (incidentally, this is not advised) you would see that the rubber keys are actually connected on one long piece of rubber. Each 'key' or raised bump on the rubber mat is hollowed, so that when you press it you make contact with a thin wafer of circuitry that sits below the rubber.

This wafer of wires criss-crossing beneath the rubber sends the keyboard signals to the computer, and these come out through two ribbons — one on each side of the computer. They are then worked through the Basic interpreter, ULA, CPU and so on.

The main reasons for the keyboard being rubber are durability and cost. Sinclair managing director Nigel Searle has said the keyboard could have been designed with full-travel typewriter keys but that it would have added to the cost unnecessarily.

As it is, a large number of peripheral manufacturers do their own 'real' keyboards for the Spectrum. Some are listed earlier in this Micropaedia. Others include Afdec's FD42 keyboard at £29 (Afdec Electronics, 318 Kempshot Lane, Basingstoke, Hants RG22 5LT) and dk'Tronics £45 keyboard with 40 alphanumeric keys and a 12 key keypad (dk'Tronics, Unit 2, Shire Hill Ind. Estate, Saffron Walden, Essex CB11 3AQ, (0799)22359).

**LN** Caps and Symbol, Z
**LPRINT** Caps and Symbol, C
**MERGE** Caps and Symbol, Caps and T
**MOVE** Caps and Symbol, Symbol and 6
**NOT** Symbol and S
**Symbol#** Caps and Symbol, Symbol and 4
**OR** Symbol and U
**OUT** Caps and Symbol, Symbol and O
**OVER** Caps and Symbol, Caps and N
**PAPER** Caps and Symbol, Caps and C
**PEEK** Caps and Symbol, O
**PI** Caps and Symbol, M
**POINT** Caps and Symbol, Symbol and 8
**READ** Caps and Symbol, A
**RESTORE** Caps and Symbol, S
**RND** Caps and Symbol, T
**SCREEN$** Caps and Symbol, Caps and K
**SGN** Caps and Symbol, F
**SIN** Caps and Symbol, Q
**SQR** Caps and Symbol, H
**STEP** Symbol and D
**STOP** Symbol and A
**STR$** Caps and Symbol, Y
**TAB** Caps and Symbol, P
**TAN** Caps and Symbol, E
**THEN** Symbol and G
**TO** Symbol and F
**USR** Caps and Symbol, L
**VAL** Caps and Symbol, J
**VAL$** Caps and Symbol, Caps and J
**VERIFY** Caps and Symbol, Caps and R
! Symbol and 1
" Symbol and P
# Symbol and 3
$ Symbol and 4
% Symbol and 5
& Symbol and 6
' Symbol and 7
( Symbol and 8
) Symbol and 9
* Symbol and B
+ Symbol and K
, symbol and N
— Symbol and J
. Symbol and M
/ Symbol and V
: Symbol and Z
; Symbol and O
< Symbol and R
= Symbol and L
> Symbol and T
? Symbol and C
@ Symbol and 2
[ Caps and Symbol, Caps and Y
\ Caps and Symbol, Caps and D
] Caps and Symbol, Caps and U
↑ Symbol and H
– Symbol and O
£ Symbol and X
{ Caps and Symbol, Caps and F
| Caps and Symbol, Caps and S
} Caps and Symbol, Caps and G
~ Caps and Symbol, Caps and A
© Caps and Symbol, Caps and P
<= Symbol and Q
>= Symbol and E
<> Symbol and W
Caps and 5
Caps and 8
Caps and 6
Caps and 7

# THE ORGANIC SPECTRUM

**Although there are few other expansion systems for the Spectrum as comprehensive and ambitious as the Basicare idea, there are other companies that offer RAM extensions for the machine.**

**Some are listed on Page 114, but others include: DIY RAM, issue 1, £42.50; issue 2, £32.50. Available from Downsway, Depot Road, Epsom, Surrey, KT17 4RJ. 48K RAM. Needs installing, instructions supplied, and uncased RAM, £22.95+£1.35 p&p. Available from Dk'Tronics, 0779 22359. 16K RAM, plugs into the back of the Spectrum and uses the same memory area.**

Basicare's Organic Micro is for users who want to get the most out of the Spectrum. Instead of having to upgrade to another computer when you find you've run out of capabilities, using the Organic Micro you can extend them, but still keep the software, literature and, of course, the machine itself.

The Organic Micro is a series of modules which stack one upon the other. Male and female pin connectors are situated on the top and bottom of each module.

This approach has the advantage of reclaiming desk-space otherwise lost under a tangle of leads and boxes. The Organic Micro was originally conceived as an add-on system for the ZX81, but because of its architecture Basicare can configure it to a variety of systems. All it takes is the development of an appropriate Persona.

The Persona is the basis of the system. It buffers signals from the Spectrum and more or less translates them into information which can be used by the Organic Micro. The Persona connects to the Spectrum via a ribbon cable which fits the computer's edge connector. All Organic Micro systems start with a Persona — it is then possible to fit modules as they are required.

The first step for many users will be extra user RAM. This is available in 8, 16 or 64K modules. These modules can be stacked up as extra memory space is required by the user.

Eventually, of course, the 64 kilobytes address space of the 8-bit Z80 microprocessor used by the Spectrum will be exhausted. At this point you can configure a module called the minimap which, as its name implies, organises extra memory into blocks and provides a way for the processor to manipulate large amounts of memory.

It does this by dividing the memory into 'segments'. The processor has access to three segments at one time, and any three segments of memory make up a page containing the full complement of addresses for the processor.

One page must have the Basic ROM plus extra space for some housekeeping tasks. The other two pages have space for the user's programs or text (see our slide-rule illustration). One of the strengths of the system is its animated graphics capabilities. These can be achieved by switching the screen back and forth between different page configurations to produce movement — rather the same principle as cine film.

Basicare has also exploited the possibilities of non-volatile RAM, offering a module which can store user programs when the system is turned off. The data is held in place by batteries which are recharged when the system is in use.

Another module, User-font, enables the user to define his own special characters. There are also modules for interfacing the system to peripheral equipment — printers, LED displays, scientific measuring equipment and so on.

One of these modules, Pericon C, has the ability to act as a Centronics interface, so text can be printed from the Spectrum to a high quality dot matrix or daisywheel printer.

The Pericon modules in general provide a means of getting some of the results of the user font features to the outside world. Pericon-a is defined as a general purpose input/output tool. It provides three eight-bit ports for connection to LEDs or relays. Pericon-b also provides three eight-bit ports which consist of 24 lines of buffered output. It can be used to drive relays directly or very long signal lines.

The memory map management of the Organic Micro is demonstrated in the diagram on the opposite page which uses a slide rule to illustrate how the memory groups interact with one another. In that diagram you'll see how different memory groups can be moved, so any segment in Group II can team up with any segment in Group III under the cursor (or in our case the processor).

Together with Group I they represent a vertical 64K 'page' of memory to the processor.

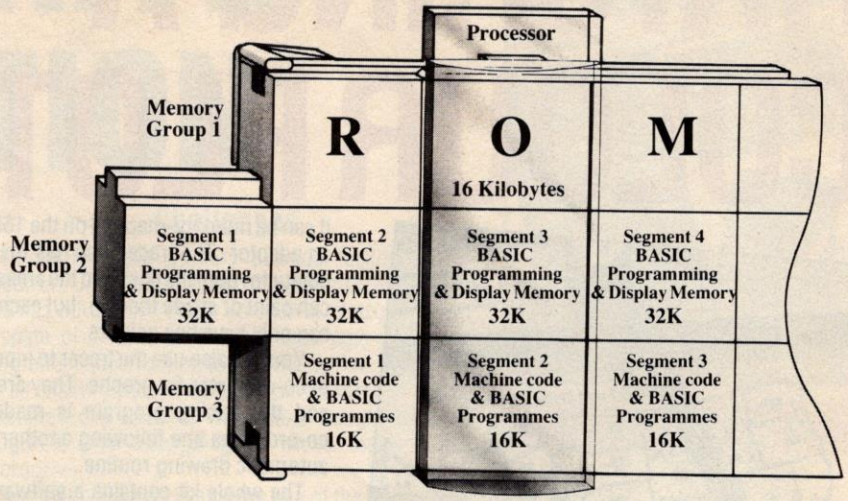
The way the Organic Micro's Minimap organises a large memory can be illustrated using a slide rule diagram. Since a Z80 processor's address space is limited to about 64,000 characters, a larger memory requires organisation.

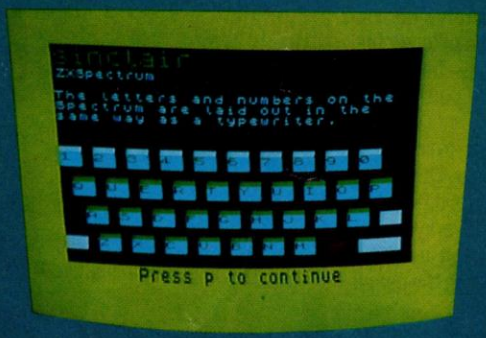
The large memory is divided into memory groups and each group is sub-divided into segments. Each segment in a given group shares the same addresses. The ROM must stay visible to the processor the whole time, permanently occupying a slab of address space. The other two memory groups, however, can be shuffled so that different configurations of their respective segments become accessible.

The Minimap slides the groups back and forth so that a combination of segments can be gathered.

These configurations make up a page of memory with a full 64K complement. Because several programs can be in memory on different segments you can use the output of one program from one page configuration for input to a program on another.

Memory Group II has a series of 32 segments containing Basic programs. Memory Group III has 16K segments of machine code or Basic routines, while Group I has just one segment, always in each page configuration, containing the Basic plus some extra information to organise the modules.


Processor
Memory Group 1
R O M
16 Kilobytes
Memory Group 2
Segment 1 BASIC Programming & Display Memory 32K
Segment 2 BASIC Programming & Display Memory 32K
Segment 3 BASIC Programming & Display Memory 32K
Segment 4 BASIC Programming & Display Memory 32K
Memory Group 3
Segment 1 Machine code & BASIC Programmes 16K
Segment 2 Machine code & BASIC Programmes 16K
Segment 3 Machine code & BASIC Programmes 16K




# Glorious colour on the small screen

This screen is a result of the output from a Spectrum to a Sony Trinitron Teletext colour TV.

The Sony range of colour TVs seems to react well to the Spectrum's colour signal and hold it without any great problem. It's worth adding, however, that the more upmarket Sonys, Hitachis and Panasonics often have an automatic tuning facility that can be troublesome in tuning a Spectrum.

On Panasonic's little Quintrix video monitor, for example, tuning a Spectrum signal is often a hit and miss operation as the TV's tuner automatically moves through all the channels and tunes into what it thinks is the strongest signal — and in some cases that's a black and white rather than a colour signal on the Spectrum.

You're likely to have better luck in tuning a Spectrum colour signal on a TV with a manual tuning knob than with an automatic search.

The same rules apply to a video recorder.

The Spectrum's colour graphics are probably its single greatest attraction.

When the machine was introduced, its colour capability broke new price records — and it's still breaking them. But to get the most out of your Spectrum's colour, you have to have the right TV.

The Spectrum screen display is 24 lines high, with a 32 character width. Colour can be used anywhere within the display, the display colour being defined as 'Paper' while 'Ink' defines text-colour. The input and report lines for programs are at the bottom within the Border, whose colour can also be varied.

The Spectrum television signal is transmitted on about Channel 36 UHF, so any television used with the machine must be able to receive UHF (as opposed to VHF) signals. Older television sets often can receive only Very High Frequency signals, instead of the Ultra High Frequency output from the Spectrum.

The UHF signal is colour-encoded in the PAL TV standard, and you must use a European TV in order to pick up that signal from the machine (*ie* you can't send a Spectrum to your cousin in Seattle and have the machine work on a North American TV). The PAL system generates a high-resolution colour picture with 625 lines and 50 frames per second.

What does all this have to do with using your Spectrum? The answer lies in the strength and accuracy of the colour signal generated by the machine. On some television receivers, that signal is simply not strong enough to be held for any appreciable length of time. The Spectrum will *not* work with all colour televisions.

If you're planning to rent a TV to use with the Spectrum, it may well be worth your while to take the machine with you to your TV rental shop when you pick the TV.

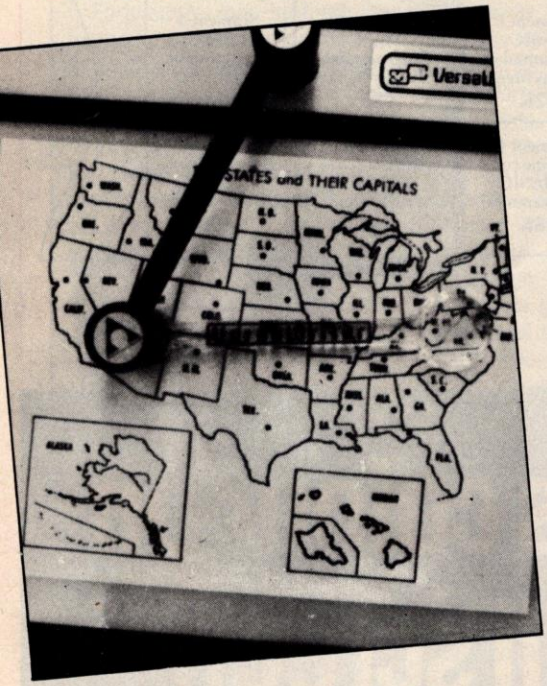
In the more likely event that you already own a TV and want to buy a Spectrum, try to get hold of a friend's machine first and try it out on your TV. If you can't pick up the Spectrum's colour signal with your TV's receiver, it could be worth waiting for Sinclair to modify the machine's video circuitry (although we wouldn't advise this because the company has taken no firm decision to do so yet). If you don't want to wait, you'll obviously have to consider changing TVs.

It should be mentioned here that if for some reason you want to run the Spectrum in black and white (and that's an odd rationale for buying a colour computer) none of this applies. Almost all TVs will display the Spectrum's signal in black and white — it's tuning the colour signal that's the tricky part.

Sinclair doesn't have a recommended list of colour TVs that are compatible with its machines, but it's widely known that several brands do the job particularly well. One of those brands is Sony and its Trinitron series of colour TVs. You'll notice that in all the Spectrum adverts, the machine is hooked up to a Sony.

So if it's good enough for Clive. . . .

# HATCHING A COLOUR PLOT




You normally input information to the Spectrum through the keyboard.

But many peripherals, including joysticks, light-pens and track balls, have been designed to help communicate with the computer by a different means.

The digital plotter or tracer is one of the easiest and most ingenious methods of transferring information from paper to the video screen. You simply move the tracer along the outline of the shape you want to copy and the digital tracer and its associated software use an analogue-to-digital converter to do the rest. Digital plotters can be used to copy maps, sketches, paintings and drawings to computers.

They can also be used to create three-dimensional drawings and colour images. User-defined graphics and text can also be incorporated once you've SAVEd the digital drawings to cassette. Digital plotters are offered for a number of popular micros, including the Spectrum.

The RD Digital Tracer is one such piece of equipment. It consists of a mechanical arm with a hinged base and an angular transducer at each joint in the arm. The transducer sends signals to the interface board (at the back of the Spectrum), which digitises this information.

It hooks up to the Spectrum through a black interface box which is plugged into the edge connector expansion port at the back of the machine. The interface box also has two red LED lights which tell you when the digital tracer is in use and if it's being used as an input/output map. Because it has only a 23-way edge connector it must be hooked up after all your other peripherals, otherwise it will plug up your interface.

On the 48K Spectrum it's I/O-mapped (Port 31), but it can be memory-mapped on the 16K Spectrum using an adaptor. The tracer also has the capability to use colour for both the lines and the areas inside them. You can paint or shade them in, but each character square can only have two colours.

You can also use the tracer to input data in the form of co-ordinates for graphs. They are stored as strings and the tracing program is made to execute the co-ordinates one following another — giving you an automatic drawing routine.

The whole kit contains a software cassette to use with the tracer, an instruction booklet, tracing sheet and template to align the tracer with the sheet. Once the program is loaded a drawing can be transferred to the screen by moving the head of the tracing arm.

The tracer can detect movements between the arm of 30cm by 20cm, and since the Spectrum's screen resolution is 256 by 175 this means that a pixel on the screen is equal to just over a millimetre — but to get such detail really depends on how finely you control the arm.

To get smooth operation, you need to make a balance between movement and resistance. This is like a joystick. If a joystick moves too freely it's difficult to control — and if it's too stiff the action is jerky.

The tracer movement is fairly free, but you can steady the movement by putting pressure on the pencil inserted in the tracing head.

The cassette contains four programs which can be used separately or merged together, and LOADing is easy.

The main program provides a number of plotting options and also allows you to use the Spectrum's Basic plotting functions. By using single-letter entries individual points can be plotted, lines drawn or deleted and text printed. There is also an option to change background and foreground colour, draw circles, define the centre and radius through the tracer position and save the screen to tape.

The tracer's position on screen is indicated by a small or large crosswire, and you can fill or shade in the area enclosing the tracer.

The four programs are written in Basic and run quite slowly. Because of this, the tracer can't keep up with rapid sketching, deletion of keyboard entries or filling in enclosed areas. Machine code would make these routines more effective. Although the cassette contains a program which allows the input of points at greater speed, the actual drawing takes place quite slowly.

The other two programs print the X and Y co-ordinates of the tracer at the top of the screen, and allow you to define characters. The former program also lets you change the origin and scale of plotting.

Priced at £49.95 it is the first of its kind for the Spectrum.

The tracer is also available for the ZX81 and there are currently plans to release it for the BBC Micro.

The Digital Tracer is available from RD Laboratories, 5 Kennedy Road, Dane End, Ware, Hertfordshire SG12 0LU. The phone number is 06333 74333.

**The numbers of peripherals for the Spectrum seems to grow almost daily.**

**Second only to the Microdrive, perhaps one of the most exciting of these new additions is the modem currently being readied for the Spectrum by Micronet. The Micronet modem will allow you to hook your Spectrum into a vast Prestel-based network of information that includes programs, news 'pages', electronic mail and other traditional Prestel services.**

**The Spectrum modem should be on sale from July 1983 at about £62. The specially designed adaptor will connect to the machine's expansion interface and have a 'modem on a chip' — meaning that you won't need fiddly acoustic couplers. So for under £180, you'll get a Prestel terminal.**

**This is an advance over even the early BBC Micronet modems, which were acoustic and sometimes suffered from background noise interference.**

**The adaptor will fit underneath the Spectrum and connect to its expansion interface. The software will be in a Read Only Memory and will turn the Spectrum into a 40-column screen with full Prestel graphics.**

**The adaptor will also allow you to print Prestel frames, using the Sinclair printer, and save frames on tape for future use.**

**In addition, you will be able to compose frames off-line — saving money on the phone bill when sending messages with the mailbox facility.**

**Contributors: Toyin Agbetu, David Janda, John Lettice, Ian Scales, Geof Wheelwright**

## NEXT WEEK

We look at software and programming for the Spectrum, including games, word processing packages, languages and books. You'll also learn how programs written for the ZX81 can be converted to run on the Spectrum and what the problems are in trying to set up a 'real' word-processing system on the Spectrum.

And in two weeks we begin a five-part Micropaedia series on sound for six popular micros. So keep your ear to the ground, your eyes on the page and your copy of *PCN* reserved at the newsagent.